ROLL-WRAPPING CONCEPTS IN THE 1990S

JUKKA PONKAMO

TODAY'S ROLL-FINISHING SYSTEMS CAN IDENTIFY, WRAP, AND LABEL SHIPPING ROLLS COMPLETELY UNTOUCHED BY HUMAN HANDS.

SHIPPING ROLLS OF PAPER ARE WRAPPED IN PAPER OR plastic to preserve their quality as they travel from the mill to the end user. This article focuses on roll-finishing methods using kraft as a wrapping material.

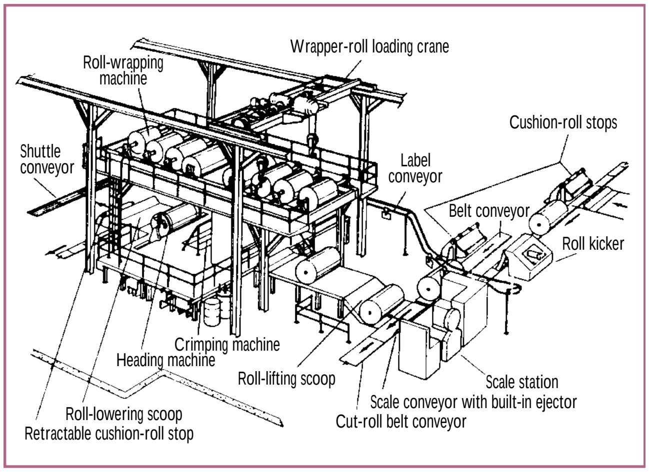
The wrap on the roll consists of a radial body wrap, an inside header, and an outside header. After the body is wrapped, the inside headers are applied to the roll ends. The overhanging body wrap is crimped over the inside headers, and the outside head is then heat-sealed or glued to the roll ends, covering the crimp. The inside head protects the roll end from damage and prevents the heat-sealed or glued outside header from sticking to the roll. The strength of the inside header becomes even more critical when rolls are stacked during storage.

The wrapper protects the roll from mechanical and climatic stresses encountered during shipment to the end user. The amount of protection depends on the nature and distance of the transportation route. A roll that is delivered by truck to a local newspaper pressroom requires considerably less protection than a roll shipped from an inland mill to overseas customers.

EARLY SYSTEMS—OVERHEAD WRAPPING LINES

The roll-wrapping machines in the 1930s were not much more than rudimentary mechanical aids in manual roll wrapping. As paper-machine widths and speeds increased, roll-wrapping machinery became more efficient. Still, as late as the 1960s, the rule of thumb was to include one wrapping line for each 500 metric tons/day of newsprint production *(1)*.

Until the early 1970s, the top-of-the-line roll wrapper was the three-stage overhead wrapping line illustrated in Fig. 1. The rolls move along a ramp under the overhead structure. Line capacity could be as high as 1400–1500 rolls per day with three or four operators. Note the label



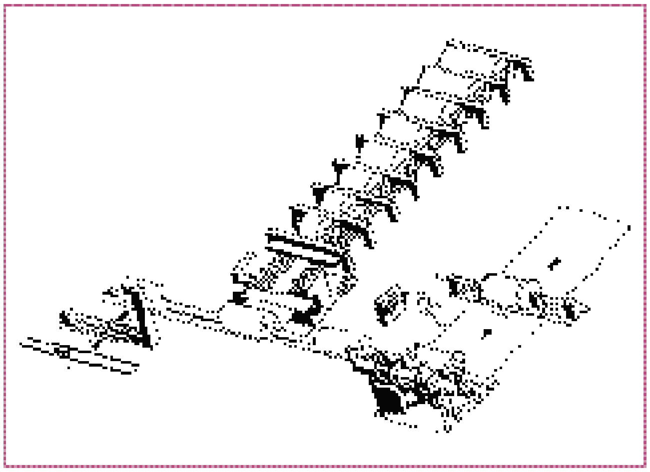
1. Overhead-style roll wrapper (1970s vintage)

conveyor from the scale station to the labeling station, where the roll was identified and weighed before it entered the wrapping line.

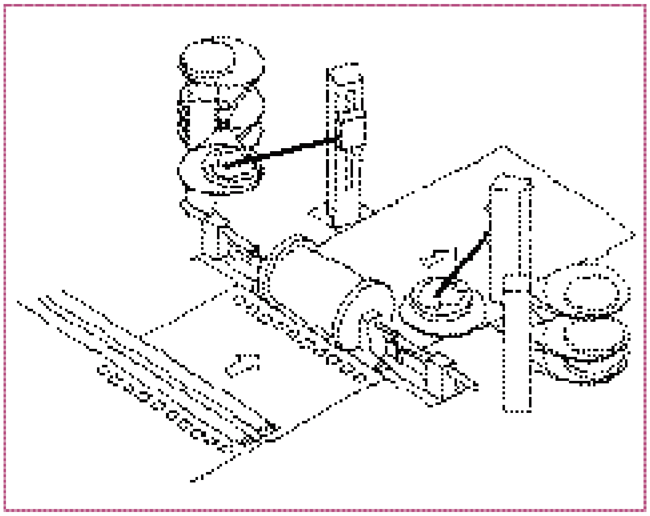
The overhead line had several drawbacks. The most obvious limitation was the lack of layout flexibility. These systems could only be located in areas with head room of approximately 7.5 m (25 ft). Other factors also contributed to the declining popularity of the overhead style:

- Concerns about operating conditions and safety
- Limited capacity
- Difficult maintenance access
- Complex sheet guiding.

While these drawbacks served as guidelines for engineers designing the next generation of roll-finishing machinery, they were not serious enough to render the



2. Low-profile wrapper



3. Outside head inserters, with heads stored on head shelves (racks)

overhead system obsolete. Indeed, overhead systems are still in use today.

THE NEXT GENERATION

Low-profile wrapping lines

System description. The low-profile wrapping line was introduced in the early 1970s. Figure 2 illustrates a typical low-profile wrapper. This system dispenses the wrapper sheet horizontally over a short distance into a nip between the shipping roll and the turning rollers. The roll is conveyed past the wrapper instead of being rolled below the wrapper, as in the overhead system. This setup makes it possible to wrap large-diameter rolls using simple equipment in areas with low overhead clearance. Other benefits of the low-profile system include:

- Easier maintenance access to all parts
- Improved operating conditions and safety
- Better tension control
- Easier to automate
- Higher capacities.

In low-profile systems, the indexing conveyor ties the different stations together. System layout is flexible, since extra stations can be added to adjust the system to fit into the building's column spacing. Space requirements for the wrapping line can also be adjusted by changing the backstand arrangement. Backstands can be on the floor or in a double-decker configuration to save space behind the wrapper. Another possibility is to locate backstands on an elevated stand. (Today's shaftless backstands eliminate the cumbersome operator function of handling heavy shafts.)

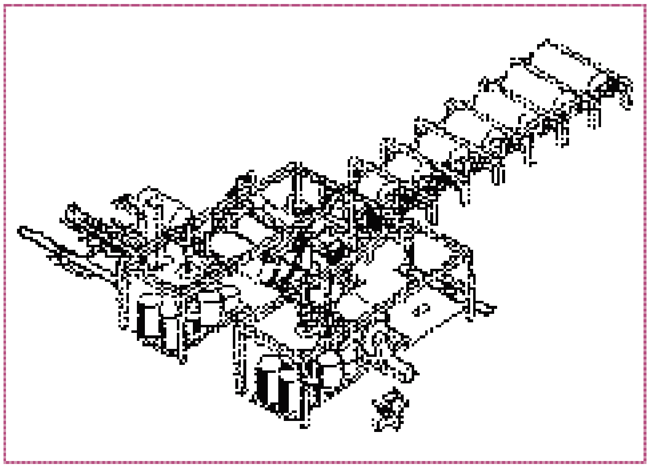
The introduction of high-tack extrudable hot-melt glues was a key factor in the emergence of fast-cycle wrapping *(2)*. However, despite the increased mechanical performance of the low-profile wrapper, worker requirements remained an issue. Until the early 1980s, a fast low-profile wrapper still required a crew of five *(1)*:

- Main operator at data entry
- Two workers for heading
- One worker for labeling
- One relief operator and stocker.

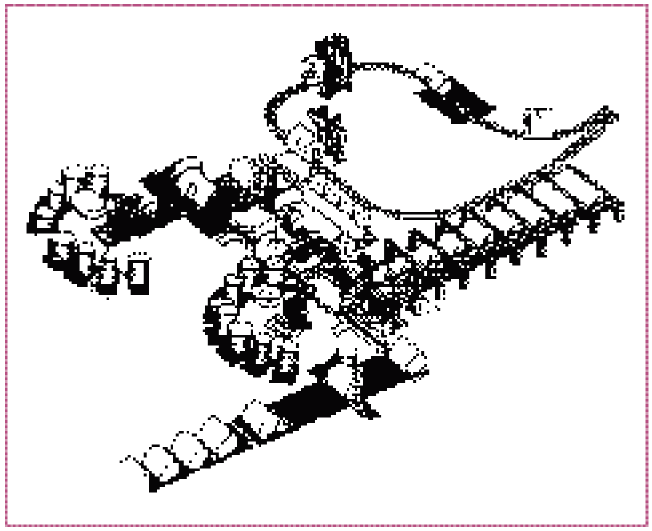
Steps toward full automation. The 1980s could be called the age of the barcode. TAPPI roll numbering—introduced in 1967—finally came into widespread use during the 1980s *(3)*. Barcodes feed information through a laser scanner, making data entry more efficient and accurate. The first roll-wrapping applications with automatic laser scanning of barcodes emerged in the early 1980s.

The initial development of automatic head inserters started in the late 1970s. The first head-inserter (inside/outside) concepts were based on head shelves, where heads were stocked. Figure 3 shows the setup for outside head inserters. The operator's main duty was to stock the head shelves. This became a major manual task, especially when using thicker, heavier inside-head material in a high-capacity line. For example, a line with a wrapping capacity of 2000 rolls per day with inside heads 3 mm (1/8 in.) thick translates to a header stack of 12 m (39.4 ft) that must be manually transferred to the head shelves.

A head-inserter system picking heads directly from pallets was developed in the late 1980s *(4)*. This is illustrated in Fig. 4. Headers, both inside and outside, are handled on pallets, and maximum stack height is approximately 1.5 m (5 ft). The latest head-inserter systems use six-axis industrial robots. Figure 5 shows a wrapping line served by two six-axis robots picking heads directly from pallets.



4. Wrapping line with head inserters that pick directly from pallets



5. Industrial six-axis robots applying inside and outside heads

The first wrapping line that featured both automatic identification of rolls and insertion of inside and outside headers was installed in a Finnish newsprint mill in late 1982 *(5)*. When the first commercial label applicators became available in the early 1980s, it was finally possible to fully automate the roll-wrapping line.

As capacity and automation increased for wrapping lines, the importance of high-quality wrapping materials became clear, since variations in quality translated to inconsistent performance *(6)*. Also, as automation increased, the systems became increasingly complex. The move from semiautomatic to fully automatic operation inevitably requires more training for operators and maintenance personnel *(6)*.

The availability of relatively inexpensive computer hardware and software has led to the development of PC-based control systems with monitors and keyboards. These new operator interfaces help increase system uptime and efficiency. These computer-based systems can

- Track historical data
- Provide help menus and diagnostics with alarms
- Track material usage
- Schedule preventive maintenance
- Inventory the availability of spare parts.

This technology shortens the learning curve for the operator while providing a much deeper understanding of the entire process.

Recent developments. The evolution of automation through the 1990s has produced refinements in several areas:

- Labeling systems with label-verification scanners to verify barcodes on applied labels
- Package quality inspections with machine vision
- Wrapping station with continuos heat sealing
- Maintenance tunnel under the wrapper for improved access while providing a safe and efficient environment for the operators
- Wrapper control room with unobstructed view of the process.

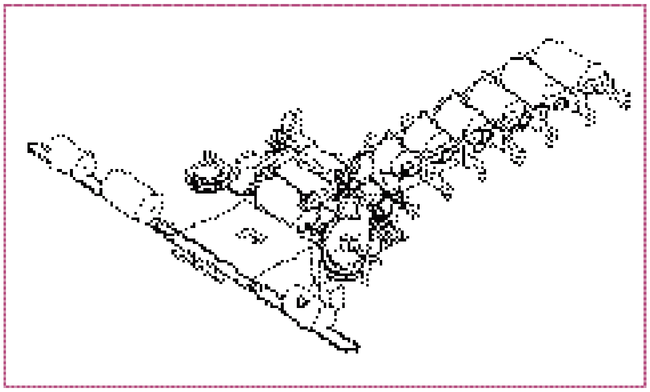
Roll sizes and weights have also grown to incredible dimensions because of the development of wide rotogravure presses. The maximum roll width specified for roto roll-wrapping lines is 3.7 m (142 in.) and weighs up to 8 metric tons (17,600 lb).

Low-capacity wrapping lines

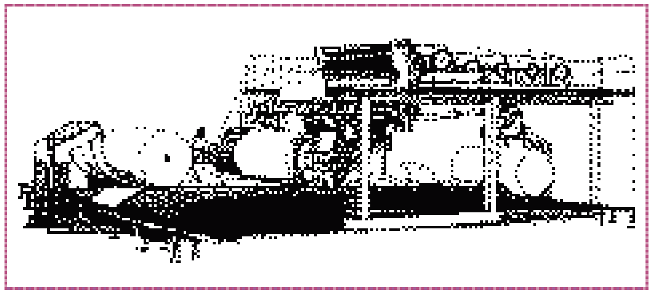
Not everyone needs (or can afford) a high-capacity, fully automatic wrapping line. Indeed, some mills are reluctant to upgrade even ancient wrapping equipment. However, trends are changing, and customers expect quality rolls. Hand-wrapped rolls are no longer acceptable in many markets. Worker safety is another issue that mills should consider when evaluating the suitability of their existing wrapping equipment.

The single-station wrapper was developed to serve the small mills that need to produce high-quality shipping rolls. These low-capacity wrapping lines provide a balance of automation and manual functions so that they can be controlled by a single operator. A low-profile-style single-station wrapper is shown in Fig. 6.

The key to roll wrapping at a single station is the installation of header press platens on a turning roller. This enables wrapping, crimping, and header pressing at a single station. A further development of this idea is an overhead-style single-station wrapper. The wrapper dispenser is raised above the turning rollers so that the roll



6. Single-station low-profile wrapper



7. Overhead-style single-station wrapper

can be rolled through the operation. This system is illustrated in Fig. 7.

WRAPPING MATERIALS

Wrapping materials have evolved to keep pace with machine developments. In the late 1940s and early 1950s, the moisture barrier for body-wrap material was asphalt laminated between two sheets of kraft liner. At high temperatures, migration of oils could make a mess, while cracking was a problem at low temperatures. In the 1950s, the asphalt was replaced by microcrystalline wax. However, wax tends to bleed at higher temperatures, so it was eventually replaced by polymers and resins, which are more heat resistant *(7)*. For demanding applications requiring high moisture-barrier capability and mechanical strength, low-density polyethylene is used as laminate or coating.

Basis weights for wrapper stock range from a little over 100 g/m^2 (60 lb/3000 ft^2) to 416 g/m^2 (256 lb/3000 ft^2). Conscientious users have their wrapper stock tailored to fit the precise needs of the application. The number of turns of body wrapper varies from 1.25 for domestic to up to 5–6 for jumbo rolls.

Chipboard, corrugated, or pressed board are used for inside headers. However, the most demanding applications are using a new type of header stock that significantly improves roll-end protection. These headers consist of shredded recycled paperboard pressed between two sheets of kraft linerboard, with a total basis weight of 1500 g/m^2 (922 lb/3000 ft^2) and a nominal thickness of 5 mm (0.2 in.). The header absorbs shock and resists collapse under pressure. It can also be polycoated for added moisture protection.

For outside heads, polycoated heat-sealing headers are used almost exclusively. Their basis weight is around 285 g/m^2 (175 lb/3000 ft^2). Die-cut header materials are preferred in automatic wrapping lines.

Mills are also increasing their use of preprinted wrapping materials, brightly colored end bands, and special preprinted labels (in addition to regular shipping labels).

CONCLUSIONS

Roll finishing has progressed from worker-intensive hand-wrapping systems to today's automated and highly efficient wrapping lines. Wrapping materials have also evolved to meet the demanding needs of a global marketplace.

With the advent of roll-tracking systems, it is now possible to identify, wrap, and label shipping rolls completely untouched by human hands. Many of these developments have been adapted for use in smaller mills, where the scale of production cannot justify the cost of a fully automated wrapping line. Single-station wrapping lines—in both low-profile and overhead styles—combine automatic and manual functions so that a single operator can control the wrapping operation. TJ

Ponkamo is product manager at Valmet, Inc., Appleton, WI 54911.

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